

An approach for the evaluation of curricula and their implementation

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Abstract: This paper presents a new approach for the evaluation of curricula at higher education. It is a first attempt to conceptualize the scope of an evaluation framework by considering static and dynamic aspects of curricula in a changing field like in computer science. It consists of two parts, namely a definition part and an execution part. It suggests applying qualitative and quantitative methods for data inquiry and several other methods for data analysis and visualization of the analysis and evaluation results. In this paper we present the related research, our setting and methodology, and the first version of our evaluation framework before concluding with a summary and future work.

Key words: Evaluation, qualitative methods, questionnaire, qualification, curricula, higher education.

INTRODUCTION

It is a great challenge to establish an evaluation process for the curricula offered in higher education. One cannot see it as a one-time activity to introduce a new curriculum to a faculty. It is also a continuous process of quality assurance, on the one side, assurance of its quality, up-to-datedness, and relevance with regard its content and methodologies applied for learning and teaching; on the other, the quality assurance of its utilization and execution in real time. Universities struggle with different approaches to find the best solution for the evaluation processes at their faculties, but the most of the time with no satisfaction. The complexity lies in the dynamics of the changes needed for the curricula selves, in the amount of students and also in the industrial and academic environment. Adaption based on these different aspects is a complex task involving several stakeholders, varying from teachers to students and others outside the universities.

The success of our alumni and alumna in computer science, no matter in academic or non-academic work, depends on our well-evaluated, adapted, quality-assured curricula and utilization of such. First of all we need to create a common understanding in our evaluation processes. For that we refer to the *computing classification system* provided by [2]. Assessment models we can apply at our higher education institutions must be developed carefully, by considering several factors. We might use industrial quality models to demonstrate effective performance [9] [10]. So we need to know the most common quality management frameworks used so far in higher education and evaluate their strengths and weaknesses. A result of such analysis shows that the *360-degree feedback methodology*, which is usually applied in human resources of organizations, *is a valuable approach*. It involves several stakeholders in assessment processes, by enabling the consideration of different views to the same subject or person assessed. For details see the Deliverable D4.2 [26, p.10].

One application of the 360-degree evaluation framework in higher education resulted in the definition of *the following steps* [9]: identification and selection of collectives of stakeholders, evaluation of stakeholders' knowledge by assigning different subsets of criteria to each collective, definition of items which are actual questions of the survey that are grouped into criteria, instrument testing to understand the questions, implementation of the online survey, aggregation process, and the analysis and interpretation. This approach is also further developed by including the collection of individuals' perception related to an educational program, a dual-scale assessment by enabling not only the judgment of the fulfillment of each evaluation criterion but also its relevance. These enable considering priorities of programs and stakeholders in the assessment process.

To design an assessment framework of knowledge, skills, and competencies we found the concept of *competence management* very relevant. Several papers are dedicated to this subject [14] [7] [12] [18] [21] [22] [27]. Some of them focus on the definition of competence management, some others try to model competence

management, and few others also try to create prototypes to manage competencies. When we design an evaluation framework for computer science curricula, we have to consider what “competencies” mean and how they can be “managed” in order to identify issues, which are relevant for their evaluation. Besides knowledge and skills, we need to evaluate competencies with our evaluation framework. For our purpose we found the definition by [22] most useful [26, p.12]. Three aspects – context, competency in terms of personal characteristics, and proficiency level – build up the concept of competence in interplay. That means that all these aspects need to be considered when it comes to assess competencies of someone.

Besides the definition of competence, we need to identify these parameters, which are relevant for evaluation of knowledge, skills, and competencies. Bodrow and Simon [7] differentiate between three groups of stakeholders: professors, alumna/alumni/students, and industries. Bodrow and Atisman [5] identified and structured *evaluation criteria for professors’ knowledge* concerning lecturing, research, and development. They also determined how to evaluate professors’ knowledge, e.g., by students [26, p.18ff]. Bodrow and Boumehdi [6] continue developing *evaluation criteria for students’ knowledge* concerning studying at the university, industrial placement, activities abroad, knowledge generated outside the university, and show an example of how to evaluate these formally. Bodrow and Valavanis [8] provide further *evaluation criteria for industry knowledge* from the perspective of university education concerning enterprise knowledge, knowledge generation and utilization in the firm, firm’s knowledge concerning its structural aspects, and firm’s knowledge concerning R&D projects. They also show how the final evaluation should look like. All these evaluation criteria and the form of capturing data are considered in the development of our evaluation framework.

The *assessment of the informatics degree programs* is another issue that we have to address with our evaluation framework. There are several criteria systems available [26]. We found EQANIEs [15] standards and accreditation criteria the most useful for this purpose. The guideline is structured in five areas and consists of the most important factors to assess. These aspects are related to the assessment of informatics degree programs as a whole. In this scope we also want to create criteria for the *assessment of the IT used* in management of curricula and their application at universities [17] as well as for the *assessment of online learning materials* [24].

In the assessment process several methods need to be applied depending on the subject to assess and its form of delivery to learners. We base our *methods on competency-based education and training* aspects and methods given by [13] and consider the approaches by [1] [16] [4].

In our evaluation framework we give special attention to the subject *professional communication*, which contains the following areas [28]:

- Effective professional communication of technical information is rarely an inherited gift, but rather needs to be taught in context throughout the undergraduate curriculum,
- Reading, understanding, and summarizing technical material, including source code and documentation,
- Writing effective technical documentation and materials,
- Dynamics of oral, written, and electronic team and group communication,
- Communicating professionally with stakeholders,
- Utilizing collaboration tools,
- Dealing with cross-cultural environments,
- Trade-offs of competing risks in software projects, such as technology, structure/process, quality, people, market, and financial.

Further aspects that need to be included in a framework are *gender* [11] [3], *future developments* [20], and *industry point of view* [23]. Finally, an adaptable, scalable, and

usable evaluation approach should include the following key elements [19]:

- It has been developed through a participatory process.
- It describes in detail the purpose of the evaluation and its intended use, including:
 - Who the audience is
 - What they want to know
 - When they want the information
 - In what form they want it
 - How they will use it
- It describes in detail the methodological approach of the evaluation, including:
 - The evaluation questions
 - The performance criteria and indicators
 - The type of data to be collected
 - How data will be collected, analyzed, and interpreted
 - Who will be involved in the evaluation process
- It has a clear timetable that is achievable and allows enough time for responses.
- The performance criteria selected reflect the agreed and documented:
 - Critical success factors, practice principles, or benchmarks
 - Intended outcomes of the community engagement activity
- It includes an explanation of how the intended outcomes relate to the activity through a clear program logic model.
- It uses data collection methods that are appropriate to the objectives and the participants.
- It makes an effort to identify and understand unexpected outcomes of the activity.
- It analyses the context of the activity (including the political, social, economic, and cultural contexts) in order to understand how this has affected the process and the outcomes of the activity.
- It includes a plan for sharing and using the learning from the evaluation, including identifying what products/forums (for example, reports, presentations, workshops, or training) will result from the evaluation, and where relevant, how the evaluation will feed into larger scale or meta-evaluation processes.

This paper is an initial attempt to conceptualize the scope of an evaluation framework for curricula at higher education. The framework we present in this paper considers static and dynamic aspects of curricula. First of all we will present our setting to contextualize our study and then the methodology we applied. Then we will introduce the evaluation framework with two aspects, namely definition and execution. We show some examples how to realize it, especially regarding the questionnaire suggested for the execution level, before concluding the paper.

THE SETTING

This research is part of a European Project FETCH (Future Education and Training in Computing: How to support learning at anytime anywhere) funded by the European Commission under the ERASMUS Programme (Project number: 539461-LLP-1-2013-1-BG-ERASMUS-ENW). The main activities are part of the Work Package 4 (European Evaluation Framework in Computing Education and Training 2020). Several preliminary results are presented and discussed in the project consortium in several meetings [25] [26]. The content presented in this paper is originated by the authors of this paper and not together with other members of the project.

METHODOLOGY

Our methodology is multifold and considers the following: A mixture of literature review, surveys, and interviews with the stakeholders involved; *recherché* and analysis of approaches, methods, and processes for evaluation of curricula and syllabi, and their

implementation in European higher education institutions and enterprises; and the discussion of our results with partners in the project in the scope of several project meetings.

In Work Package 4 of the project we created a survey to capture the relevance of certain criteria in teaching, research, and industry [26]. Project partners filled in the survey. In the first part of the survey, we asked 15 one-choice questions; we got 90 completed answers, and 156 survey visits. In the second part of the survey we asked the following open question: *What else do you think is also relevant and important? Please provide us your ideas and suggestions in the following text box.* There were in total 52 completed responses whereas 43 answered the question and 9 skipped it. Finally, in the third part we focused on research and industrial development. There were 7 multiple-choice questions and one text box. We had 76 completed responses (114 survey visits) in this part of the survey. The survey results helped us to set priorities in the development of our evaluation framework.

RESULT: OUR APPROACH TO EVALUATION

In this section we want to introduce the evaluation framework we developed based on our study in the project after giving its definition as stated in the project proposal of FETCH:

“European Evaluation Framework in Computing Education and Training 2020 (EEFCET-2020) aligns with EQF (European Qualification Framework), and will evaluate the three factors: Knowledge, Skills and Competences gained from the Computing Education and Training. It will propose ways to evaluate the quality of digital curricula, syllabi, and will assess social networks as a medium for education.”

“EEFCET-2020 will consider an evaluation of curricula and syllabi of bachelors, masters, and doctors in Computing, and their implementation in European higher education institutions. EEFCET-2020 will appraise three factors: Knowledge, Skills and Competences gained from Computing Education and Training.”

In our approach the evaluation framework consists of two levels: definition and execution. On the definition level, it considers mainly a curriculum that is implemented at a higher education institution as a static and general piece of artifact (usually as a document) consisting of details on several learning and teaching related aspects of the curriculum (see the Figure 2). On the other hand, the instantiation of a curriculum has other qualities for evaluation like processes carried out and established, resources used, and results achieved for different stakeholders involved in the utilization of the curriculum in higher education.

Definition Level

At the definition level the curriculum is evaluated as a static, general description of a study consisting of several parts:

- 1) Aims and objectives—This describes the goals of a curriculum, normally structured in three areas: Domain and methodology knowledge; cognitive and practical skills; social competences, competences for innovation and creativity. The main question in this area is to which degree the aims and objectives of a curriculum are up-to-date and balanced in terms of knowledge, skills, and competences.
- 2) Admission conditions—It describes the conditions for the admission for the study of the curriculum. This is relevant in case of master curricula or PhD studies. Bachelor studies usually do not have any restrictions for the admission process.
- 3) Structure—A curriculum is generally structured into modules, which might be interdependent from each other. Modules have a title and a size. They are described with a short summary, expected learning outcomes in terms of knowledge, skills, and competences, syllabus, expected prerequisites (like other

modules or single courses), teaching and learning methods as well as adequate assessment of performance, courses included in the module (type, size, subject). Besides the quality and quantity of the modules and their relevance considering the aims and objectives of the curriculum the balance and dependencies among modules as well as the flexibility for assembling modules by students are further categories to assess.

- 4) Assessment mechanisms—Curriculums contain usually several measures for the assessment of students' learning effort and qualification. These might be defined on the study level, module level, or course level. All levels are relevant for evaluation purposes.
- 5) Quality assurance—QA describes how the quality of the curriculum will be assured during the course of utilization in the mid- and long-term. It must contain measures for assessment the curriculum as a whole as well as issues of adapting the contents, methods, structures, etc. if necessary.
- 6) Interim regulations—They help to define the transitory provisions. A well-designed curriculum considers the previous and similar studies and communicates clearly what the differences are and what interim regulations must be applied.

Execution Level

At the execution level the curriculum is seen as a dynamic, specific entity consisting of resources, processes, and results, which are defined in relation to stakeholders. Stakeholders vary from students, teachers, administration staff, and faculty on the one hand, to alumni and industries on the other.

- 1) Resources contain information provided at all and learning materials including eLearning environments.
- 2) Processes contain general services offered to learners, learning activities, and training support including services provided on electronic environments.
- 3) Results cover aspects of course efficiency, knowledge increase, and motivation to learn.

In terms of questionnaires data can be gathered. They are specific for each stakeholder. They need to be filled in before the semi-structured interviews with the most key stakeholders can be carried out. These enable reasoning of certain results gathered in surveys and better understanding of the circumstances, constraints, and relations. After analyzing the data inquiry discussions can be conducted and furthermore analyzed by means of focus groups. While questionnaires help gathering *what* systematically, semi-structured interviews and focus groups enable finding out *why* certain answers are given, *why* certain processes have been established, what the reasons can be for certain phenomenon. The combination of quantitative and qualitative methods makes data inquiry and analysis complete and successful.

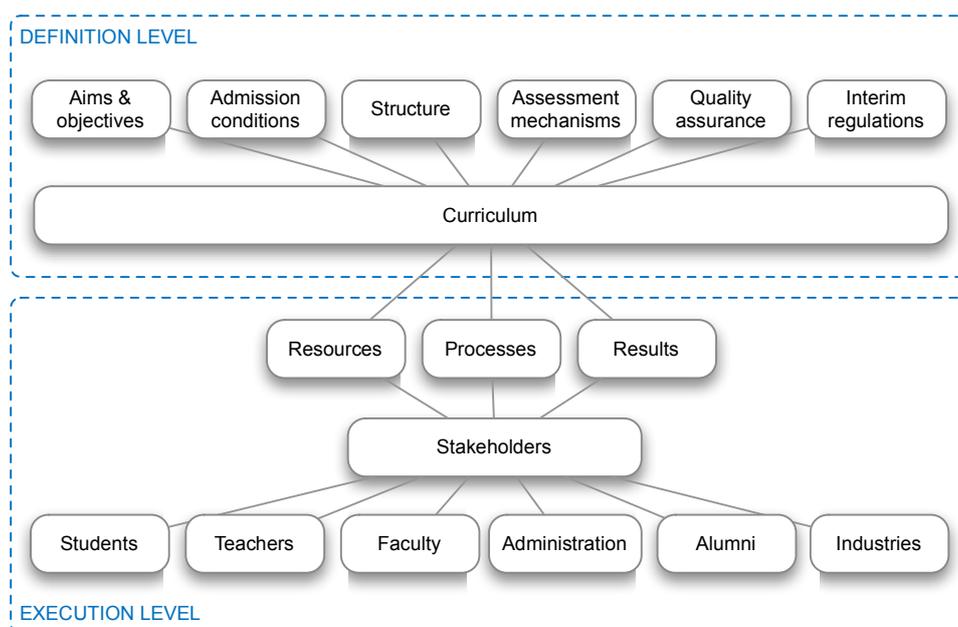


Figure 2. Our approach to evaluation of curricula with two levels: Definition level and execution level

In the following we show the main areas of the questionnaires used for students, teachers, and administration. These questions are based on and adapted from SEVAQ+ questionnaires²².

Questionnaire for the students

Resources

1. Information provided: Information about the learning provider – whether the learning provider has good references – how much and how qualified detailed information is provided about the quality procedures and certifications of the learning provider.
2. Learning materials: Availability of the provided learning and complementary learning material – pedagogical learning – usability and accessibility – instructional design – multimodality and interaction.

Processes

1. General services offered to the learner: Guidance in the choice and selection of courses – registration process – welcoming on the course.
2. Learning activities: Time management – access to resources – pedagogical methods – blended approach (face to face + eLearning) – collaboration and self-study.
3. Training support: Planning of training support – quality of training support – online communication – peer online communication – group learning support – respect of the contract by the training provider – respect of the contract by the student.

Results

1. Course efficiency: Perceived quality (training staff, resources, services).
2. Knowledge increase: Overall knowledge at the end of the course – evaluation of training goals.
3. Motivation to learn: Learning preferences – learning management – self-motivation.

Questionnaire for the teachers

Resources

1. Learning materials: Pedagogical aspects of learning content – usability and accessibility – instructional design – multimodality and interaction.

²² <http://sevaq.efquel.org/>

Processes

1. General services offered to the learner: Guidance in the choice and selection of course – registration process – welcoming on the course.
2. Learning activities: Time management – access to resources – pedagogical methods – blended approach (face to face + eLearning) – collaboration and self-study.
3. Training support: Planning of training support – quality of training support – online communication – peer online communication – group learning support.
4. Respect of contracts: Respect of the contract by the training provider – respect of the contract by the student.

Results

1. Course efficiency: Perceived quality (training staff, resources, services).
2. Knowledge increase: Overall knowledge at the end of the course – evaluation of training goals.
3. Performance of learning outcomes: Perspective of others than learners.
4. Motivation to learn: Awareness of learning preferences – learning management – self-motivation.

Questionnaire for the administrative staff**Processes**

1. Respect of contracts: Respect of the contract by the training provider – respect of the contract by the student.

Results

1. Course efficiency: Perceived quality (training staff, resources, services).

The areas presented above are of course much more detailed in the questionnaire with further questions. To give here some examples, the following questions are defined for the section “*Questions for the students – Resources – 1. Information provided – Information about the learning provider*”:

- Is any relevant information available about the teacher or his/her group related to the subject of learning? In which format? What is the quantity and quality of this information?
- Is there any relevant information about the services provided by the teacher or his/her group related to the learning process? In which format? What is the quantity and quality of this information?
- Is this information up-to-date?
- Is this information accessible for everyone?
- Is this information available in the Internet? How? In which format?

Another example is for the section “*Questions for the students – Resources – 1. Information provided – whether the learning provider has good references*”:

- Is there any information about the knowledge, skills and experiences of the teacher or his/her group involved in the teaching? In which format? What is the quantity and quality of this information?
- Are there references to assess the perceived quality of the teacher or his/her group involved in the teaching? In which format?
- Are the (good or bad) references up-to-date?

Or on the question “Questions for the students – Resources – 1. Information provided – how much and how qualified detailed information is provided about the quality procedures and certifications of the learning provider”:

- How trustful are the certifications stating the quality of the knowledge, skills, and experiences of the teacher or his/her group involved in the teaching?
- What are the quality measures showing the quality of the knowledge, skills, and experiences of the teacher or his/her group involved in the teaching?
- Are there verified procedures or certifications showing these values? In which format? What is the quantity and quality of this information?

The detailed questions can be answered with options ranging from 1 to 5. The answers can be summarized and the total can be interpreted as the degree of well establishment of an evaluation process for the curricula at a higher education provider. The range can span from “no evaluation processes at all” to “a well-defined and – established evaluation mechanism with continuous improvement measures”. Due to space reasons no further details are presented here.

CONCLUSIONS

In this paper, we presented our approach for the evaluation of curricula at higher education institutions. It is a first attempt to conceptualize the scope of an evaluation framework. The related work is presented, requirements are defined, components and mechanisms of a framework are presented, and some details of its components are exemplified. How the results of the evaluation can be categorized and visualized are important issues. However, due to the space reasons these topics are not presented and discussed in this paper and will be dealt with in the future work.

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